

**B.Sc. Honors Physics syllabus 2020-23**

**Under**

**CHOICE BASED CREDID SYSTEM**

**School of Studies in Physics  
Jiwaji University, Gwalior**

**CORE COURSES PHYSICS MAJOR**

**(B.Sc. HONOURS IN PHYSICS)**

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## Semester I

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### PHYSICS-C I: MATHEMATICAL PHYSICS-I

**Credits: Theory-04, Practicals-02**

**Theory: 40 Lectures**

*The emphasis of course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems, seen and unseen.*

#### **Calculus:**

Recapitulation: Limits, continuity, average and instantaneous quantities, differentiation. Plotting functions. Intuitive ideas of continuous, differentiable, etc. functions and plotting of curves. Approximation: Taylor and binomial series statements only. First Order Differential Equations and Integrating Factor. **6 Lectures**

Second Order Differential equations: Homogeneous Equations with constant coefficients. Wronskian and general solution. Statement of existence and Uniqueness Theorem for Initial Value Problems. Particular Integral. **6 Lectures**

Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers. **6 Lectures**

#### **Vector Calculus:**

Recapitulation of vectors: Properties of vectors under rotations. Scalar product and its invariance under rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively. Scalar and Vector fields. **3 Lectures**

Vector Differentiation: Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities, Gradient, divergence, curl and Laplacian in spherical and cylindrical coordinates. **6 Lectures**

Vector Integration: Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications no rigorous proofs. **8 Lectures**

#### **Orthogonal Curvilinear Coordinates:**

Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems. **3 Lectures**

#### **Dirac Delta function and its properties:**

Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function. **2 Lectures**

#### **Reference Books:**

- Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7<sup>th</sup> Edn., Elsevier.
- An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI Learning
- Differential Equations, George F. Simmons, 2007, McGrawHill.
- Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
- Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, VivaBook
- Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.



## PHYSICS LAB- C I LAB:

40

### Lectures

*The aim of this Lab is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.*

- *Highlights the use of computational methods to solve physical problems*
- *The course will consist of lectures both theory and practical in the Lab*
- *Evaluation done not on the programming but on the basis of formulating the problem*
- *Aim at teaching students to construct the computational problem to be solved*
- *Students can use any one operating system Linux or Microsoft Windows*

Topics	Description with Applications
Introduction and Overview	Computer architecture and organization, memory and input / output devices
Basics of scientific computing	Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow & overflow-emphasize the importance of making equations in terms of dimensionless variables, Iterative methods
Errors and error Analysis	Truncation and round off errors, Absolute and relative errors, Floating point computations.
Review of C & C++ Programming fundamentals	Introduction to Programming, constants, variables and data types, operators and Expressions, I/O statements, scanf and printf, c in and c out, Manipulators for data formatting, Control statements decision making and looping statements <i>If-statement. If-else Statement. Nested if Structure. Else-if Statement. Ternary Operator. Goto Statement. Switch Statement. Unconditional and Conditional Looping. While Loop. Do-While Loop. FOR Loop. Break and Continue Statements. Nested Loops, Arrays 1D &amp; 2D and strings, user defined functions, Structures and Unions, Idea of classes and objects</i>
Programs:	Sum & average of a list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending descending order, Binary search
Random number generation	Area of circle, area of square, volume of sphere, value of $\pi$
Solution of Algebraic and Transcendental equations by Bisection, Newton Raphson and Secant methods	Solution of linear and quadratic equation, solving $\alpha = \tan \alpha$ ; $I = I_0 [\sin \alpha / \alpha]^2$ in optics
Interpolation by Newton Gregory Forward and Backward difference formula, Error estimation of linear interpolation	Evaluation of trigonometric functions e.g. $\sin \theta$ , $\cos \theta$ , $\tan \theta$ , etc.
Numerical differentiation Forward and Backward difference formula and Integration Trapezoidal and Simpsonrules, Monte Carlo method	Given Position with equidistant time data to calculate velocity and acceleration and vice versa. Find the area of B-H Hysteresis loop

Also attempt some problems on differential equations like:



1. Solve the coupled first order differential equations

$$Dy/dx = y + x - x^3/3 \quad \text{and} \quad dy/dx = -x$$

for four initial conditions  $x_0 = 0$ ,  $y_0 = -1, -2, -3, -4$ . Plot  $x$  vs  $y$  for each of the four initial conditions on the same screen for  $0 \leq t \leq 15$ .

2. The ordinary differential equation describing the motion of a pendulum is

$$\vartheta'' = -\sin \vartheta$$

The pendulum is released from rest at an angular displacement  $\alpha$  i.e.  $\vartheta(0) = \alpha, (\quad)$

$\vartheta'(0) = 0$ . Use the RK4 method to solve the equation for  $\alpha = 0.1, 0.5$  and  $1.0$  and plot  $\vartheta$  as a function of time in the range  $0 \leq t \leq 8\pi$ . Also, plot the analytic solution valid in the small  $\vartheta$   $\sin \vartheta \approx \vartheta$ .  $(\quad)$

3. Solve the differential equation:

$$x^2 (d^2y/dx^2) - 4x(1+x)(dy/dx) + 2(1+x)y = x^3$$

with the boundary conditions:

$$x = 1, y = 1/2 e^2, dy/dx = -3/2 e^2 - 0.5, \text{ in the range } 1 \leq x \leq 3. \text{ Plot } y \text{ and } y''$$

against  $x$  in the given range. Both should appear on the same graph.

#### Referred Books:

- Introduction to Numerical Analysis, S.S. Sastry, 5<sup>th</sup> Edn., 2012, PHI Learning Pvt.Ltd.
- Numerical Computational Programming, P.B. Patil and U.P. Verma, Narosa Pub. New Delhi
- Schaum's Outline of Programming with C++. J. Hubbard, 2000, McGraw-Hill Pub.
- Numerical Recipes in C: The Art of Scientific Computing, W.H. Press et al, 3<sup>rd</sup> Edn., 2007, Cambridge University Press.
- Elementary Numerical Analysis, K.E. Atkinson, 3<sup>rd</sup> Edn., 2007, Wiley India Edition.
- Numerical Methods for Scientists & Engineers, R.W. Hamming, 1973, Courier Dover Pub.





## PHYSICS-C II: MECHANICS

**Credits: Theory-04, Practicals-02 Theory: 40 Lectures**

**Fundamentals of Dynamics:** Reference frames. Inertial frames; Galilean transformations; Galilean invariance. Review of Newton's Laws of Motion. Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse. Momentum of variable-mass system: motion of rocket.

**4Lectures**

**Work and Energy:** Work and Kinetic Energy Theorem. Conservative and non-conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Elastic potential energy. Force as gradient of potential energy. Work & Potential energy. Work done by non-conservative forces. Law of conservation of Energy.

**2Lectures**

**Collisions:** Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames.

**2Lectures**

**Rotational Dynamics:** Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation.

**7Lectures**

**Elasticity:** Relation between Elastic constants. Twisting torque on a Cylinder or Wire.

**1Lectures**

**Fluid Motion:** Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube.

**2Lectures**

**Gravitation and Central Force Motion:** Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere.

**3Lectures**

Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system GPS. Physiological effects on astronauts.

**6Lectures**

**Oscillations:** SHM: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor.

**4Lectures**

**Non-Inertial Systems:** Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems.

**3Lectures**

**Special Theory of Relativity:** Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with

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velocity. Massless Particles. Mass-energy Equivalence. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy and Momentum. Energy- Momentum Four Vector.

**6Lectures**

**Reference Books:**

- An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
- Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
- Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
- Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.
- Feynman Lectures, Vol. I, R.P. Feynman, R.B. Leighton, M. Sands, 2008, Pearson Education
- Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

**Additional Books for Reference**

- Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
  - University Physics. F.W. Sears, M.W. Zemansky, H.D. Young 13/e, 1986, Addison Wesley
  - Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A. Serway, 2010, Cengage Learning
  - Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.
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**PHYSICS LAB-C II LAB**

**40 Lectures**

1. Measurements of length or diameter using vernier caliper, screw gauge and travelling microscope.
2. To study the random error in observations.
3. To determine the height of a building using a Sextant.
4. To study the Motion of Spring and calculate a Spring constant,  $b$   $g$  and  $c$  Modulus of rigidity.
5. To determine the Moment of Inertia of a Flywheel.
6. To determine  $g$  and velocity for a freely falling body using Digital Timing Technique
7. To determine Coefficient of Viscosity of water by Capillary Flow Method Poiseuille's method.
8. To determine the Young's Modulus of a Wire by Optical Lever Method.
9. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
10. To determine the elastic Constants of a wire by Searle's method.
11. To determine the value of  $g$  using Bar Pendulum.
12. To determine the value of  $g$  using Kater's Pendulum.

**Reference Books**

- Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4<sup>th</sup> Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11<sup>th</sup> Edn, 2011, Kitab Mahal





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## Semester II

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### PHYSICS-C III: ELECTRICITY AND MAGNETISM

**Credits: Theory-04, Practicals-02 Theory: 40 Lectures**

#### **Electric Field and Electric Potential**

Electric field: Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry. **4 L**

Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. The Uniqueness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole. **4L**

Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. Method of Images and its application to: 1 Plane Infinite Sheet and 2 Sphere. **5L**

**Dielectric Properties of Matter:** Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor parallel plate, spherical, cylindrical filled with dielectric. Displacement vector **D**. Relations between **E**, **P** and **D**. Gauss' Law in dielectrics. **5L**

**Magnetic Field:** Magnetic force between current elements and definition of Magnetic Field **B**. Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment Analogy with Electric Dipole. Ampere's Circuital Law and its application to 1 Solenoid and 2 Toroid. Properties of **B**: curl and divergence. Vector Potential. Magnetic Force on 1 point charge 2 current carrying wire 3 between current elements. Torque on a current loop in a uniform Magnetic Field. **6L**

**Magnetic Properties of Matter:** Magnetization vector **M**. Magnetic Intensity **H**. Magnetic Susceptibility and permeability. Relation between **B**, **H**, **M**. Ferromagnetism. B-H curve and hysteresis. **3L**

**Electromagnetic Induction:** Faraday's Law. Lenz's Law. Self Inductance and Mutual Inductance. Reciprocity Theorem. Energy stored in a Magnetic Field. Introduction to Maxwell's Equations. Charge Conservation and Displacement current. **4L**

**Electrical Circuits:** AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series LCR Circuit: 1 Resonance, 2 Power Dissipation and 3 Quality Factor, and 4 Band Width. Parallel LCR Circuit. **4L**

**Network theorems:** Ideal Constant-voltage and Constant-current Sources. Network Theorems: Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem. Applications to dc circuits. **3 L**

**Ballistic Galvanometer:** Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping. CDR. **2 L**



**Reference Books:**

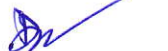
- Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, TataMcGraw
  - Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-HillEducation
  - Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, BenjaminCummings.
  - Feynman Lectures Vol.2, R.P.Feynman, R.B.Leighton, M. Sands, 2008, PearsonEducation
  - Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford UniversityPress.
  - Electricity and Magnetism, J.H.Fewkes&J.Yarwood. Vol. I, 1991, Oxford Univ.Press.
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**PHYSICS LAB-C III LAB****40****Lectures**

1. Use a Multimeter for measuring a Resistances, b AC and DC Voltages, c DC Current, d Capacitances, and e Checking electrical fuses.
2. To study the characteristics of a series RC Circuit.
3. To determine an unknown Low Resistance using Potentiometer.
4. To determine an unknown Low Resistance using Carey Foster's Bridge.
5. To compare capacitances using De'Sauty's bridge.
6. Measurement of field strength B and its variation in a solenoid determine dB/dx
7. To verify the Thevenin and Norton theorems.
8. To verify the Superposition, and Maximum power transfer theorems.
9. To determine self inductance of a coil by Anderson's bridge.
10. To study response curve of a Series LCR circuit and determine its a Resonant frequency, b Impedance at resonance, c Quality factor Q, and d Bandwidth.
11. To study the response curve of a parallel LCR circuit and determine its a Anti-resonant frequency and b Quality factor Q.
12. Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer
13. Determine a high resistance by leakage method using Ballistic Galvanometer.
14. To determine self-inductance of a coil by Rayleigh's method.
15. To determine the mutual inductance of two coils by Absolute method.

**Reference Books**

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
  - A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11<sup>th</sup> Ed., 2011, KitabMahal
  - Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4<sup>th</sup> Edition, reprinted 1985, Heinemann Educational Publishers
  - A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, VaniPub.
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## PHYSICS-C IV: WAVES AND OPTICS

Credits: Theory-04, Practicals-02

Theory: 40 Lectures

**Superposition of Collinear Harmonic oscillations:** Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies Beats. Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences. **4Lectures**

**Superposition of two perpendicular Harmonic Oscillations:** Graphical and Analytical Methods. Lissajous Figures 1:1 and 1:2 and their uses. **2Lectures**

**Wave Motion:** Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive Travelling Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Water Waves: Ripple and Gravity Waves. **3Lectures**

**Velocity of Waves:** Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction. **4Lectures**

**Superposition of Two Harmonic Waves:** Standing Stationary Waves in a String: Fixed and Free Ends. Analytical Treatment. Phase and Group Velocities. Changes with respect to Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's Experiment. Longitudinal Standing Waves and Normal Modes. Open and Closed Pipes. Superposition of N Harmonic Waves. **4Lectures**

**Wave Optics:** Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence. **2Lectures**

**Interference:** Division of amplitude and wave front. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination Haidinger Fringes; Fringes of equal thickness Fizeau Fringes. Newton's Rings: Measurement of wavelength and refractive index. **7Lectures**

**Interferometer:** Michelson Interferometer-1 Idea of form of fringes No theory required, 2 Determination of Wavelength, 3 Wavelength Difference, 4 Refractive Index, and 5 Visibility of Fringes. Fabry-Perot interferometer. **2Lectures**

**Diffraction:** Kirchhoff's Integral Theorem, Fresnel-Kirchhoff's Integral formula and its application to rectangular slit. **2Lectures**

**Fraunhofer diffraction:** Single slit. Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating. **5Lectures**

**Fresnel Diffraction:** Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire. **5Lectures**



### Reference Books

- Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, TataMcGraw-Hill.
  - Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
  - Principles of Optics, Max Born and Emil Wolf, 7<sup>th</sup> Edn., 1999, Pergamon Press.
  - Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
  - The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
  - The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
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### PHYSICS LAB- C IV LAB

### 40 Lectures

1. To determine the frequency of an electric tuning fork by Melde's experiment and verify  $\lambda^2 - T$  law.
2. To investigate the motion of coupled oscillators.
3. To study Lissajous Figures.
4. Familiarization with: Schuster's focusing; determination of angle of prism.
5. To determine refractive index of the Material of a prism using sodium source.
6. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
7. To determine the wavelength of sodium source using Michelson's interferometer.
8. To determine wavelength of sodium light using Fresnel Biprism.
9. To determine wavelength of sodium light using Newton's Rings.
10. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
11. To determine wavelength of 1 Na source and 2 spectral lines of Hg source using plane diffraction grating.
12. To determine dispersive power and resolving power of a plane diffraction grating.

### Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
  - A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11<sup>th</sup> Ed., 2011, Kitab Mahal
  - Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4<sup>th</sup> Edition, reprinted 1985, Heinemann Educational Publishers
  - A Laboratory Manual of Physics for undergraduate classes, D.P. Khandelwal, 1985, VaniPub.
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### Semester III

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#### **PHYSICS - C V: MATHEMATICAL PHYSICS-II** **Credits: Theory-04, Practicals-02**

**THEORY**  
**40 Lectures**

*The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.*

**Fourier Series:** Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions Statement only. Expansion of periodic functions in a series of sine and cosine functions, and determination of Fourier coefficients. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non-periodic functions over an interval. Even and odd functions and their Fourier expansions. Application. Summing of Infinite Series. Term-by-Term differentiation and integration of Fourier Series. Parseval Identity. **10 L**

**Frobenius Method and Special Functions:** Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions and Orthogonality. **16 L**

**Some Special Integrals:** Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function Probability Integral. **3 L**

**Theory of Errors:** Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error. **2 L**

**Partial Differential Equations:** Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Wave equation and its solution for vibrational modes of a stretched string, rectangular and circular membranes. **9L**

#### **Reference Books:**

- Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
  - Fourier Analysis by M.R. Spiegel, 2004, TataMcGraw-Hill.
  - Mathematics for Physicists, Susan M. Lea, 2004, ThomsonBrooks/Cole.
  - Differential Equations, George F. Simmons, 2006, TataMcGraw-Hill.
  - Partial Differential Equations for Scientists & Engineers, S.J. Farlow, 1993, DoverPub.
  - Mathematical methods for Scientists & Engineers, D.A. McQuarrie, 2003, VivaBooks
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## PHYSICS -C V MATHEMATICAL PHYSICS-II

### Credits: Practicals-02

LAB  
40 Lectures

*The aim of this Lab is to use the computational methods to solve physical problems. Course will consist of lectures both theory and practical in the Lab. Evaluation done not on the programming but on the basis of formulating the problem*

#### Topics in RED and Description with Applications IN BLACK

Introduction to Numerical computation software Scilab

Introduction to Scilab, Advantages and disadvantages, Scilab environment, Command window, Figure window, Edit window, Variables and arrays, Initialising variables in Scilab, Multidimensional arrays, Subarray, Special values, Displaying output data, data file, Scalar and array operations, Hierarchy of operations, Built in Scilab functions, Introduction to plotting, 2D and 3D plotting 2, Branching Statements and program design, Relational & logical operators, the while loop, for loop, details of loop operations, break & continue statements, nested loops, logical arrays and vectorization 2 User defined functions, Introduction to Scilab functions, Variable passing in Scilab, optional arguments, preserving data between calls to a function, Complex and Character data, string function, Multidimensional arrays 2 an introduction to Scilab file processing, file opening and closing, Binary I/o functions, comparing binary and formatted functions, Numerical methods and developing the skills of writing a program2.

Curve fitting, Least square fit, Goodness of fit, standard deviation

Ohms law to calculate R, Hooke's law to calculatespring constant

Solution of Linear system of equations by Gauss elimination method and Gauss Seidal method.

Diagonalization of matrices, Inverse of a matrix, Eigen vectors, eigen values problems

Solution of mesh equations of electric circuits 3meshes Solution of coupled spring mass systems 3masses

Solution of ODE First order Differential equation Euler, modified Euler and Runge-Kutta second order methods Second order differential equation Fixed difference method

First order differential equation

- Radioactive decay
- Current in RC, LC circuits with DCsource
- Newton's law of cooling
- Classical equ. of motion II order Diff. Equ.
- Harmonic oscillator no friction
- Damped Harmonicoscillator
- Overdamped
- Critical damped
- Oscillatory
- Forced Harmonicoscillator
- Transientand
- Steady state solution Apply above to LCR circuits also

Using Scicos / xcoss

- Generating square wave, sine wave, saw toothwave
- Solution to harmonicoscillator
- Study of beatphenomenon Phase spaceplots

#### Reference Books:

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S.J.Bence, 3<sup>rd</sup> ed., 2006, Cambridge University Press
- Complex Variables, A.S. Fokas& M.J. Ablowitz, 8<sup>th</sup> Ed., 2011, Cambridge Univ.Press
- First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A.V. Wouwer, P. Saucez, C.V. Fernández. 2014 Springer
- Scilab by example: M. Affouf 2012, ISBN:978-1479203444
- Scilab A free software to Matlab: H.Ramchandran, A.S.Nair. 2011 S.Chand&Company
- Scilab Image Processing: Lambert M. Surhone. 2010 BetascriptPublishing



## PHYSICS-C VI: THERMAL PHYSICS

**Credits: Theory-04, Practicals-02**

**Theory: 40 Lectures**

*Include related problems for each topic*

### Introduction to Thermodynamics

**Zeroth and First Law of Thermodynamics:** Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between  $C_p$  and  $C_v$ , Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Co-efficient. **5L**

**Second Law of Thermodynamics:** Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot's Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, 2<sup>nd</sup> Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale. **6L**

**Entropy:** Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe. Entropy Changes in Reversible and Irreversible Processes. Principle of Increase of Entropy. Temperature-Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero. **5L**

**Thermodynamic Potentials:** Extensive and Intensive Thermodynamic Variables. Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Their Definitions, Properties and Applications. Surface Films and Variation of Surface Tension with Temperature. Magnetic Work, Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equations **5L**

**Maxwell's Thermodynamic Relations:** Derivations and applications of Maxwell's Relations, (1) Clausius Clapeyron equation, (2) Values of  $C_p - C_v$ , (3) Tds Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (5) Energy equations, (6) Change of Temperature during Adiabatic Process. **5L**

### Kinetic Theory of Gases

**Distribution of Velocities:** Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Doppler Broadening of Spectral Lines and Stern's Experiment. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy **No proof required.** Specific heats of Gases. **5L**

**Molecular Collisions:** Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: 1 Viscosity, 2 Thermal Conductivity and 3 Diffusion. Brownian Motion and its Significance. **4L**

**Real Gases:** Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO<sub>2</sub> Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves. p-V Diagrams. Joule's Experiment. Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Porous Plug Experiment. Joule-Thomson Effect for Real and Van der Waal Gases. Temperature of Inversion. Joule-Thomson Cooling. **5L**



**Reference Books:**

- Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
  - A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1958, Indian Press
  - Thermal Physics, S. Garg, R. Bansal and Ghosh, 2<sup>nd</sup> Edition, 1993, Tata McGraw-Hill
  - Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
  - Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
  - Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2<sup>nd</sup> Ed., 2012, Oxford University Press
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**PHYSICS LAB- C VI THERMAL PHYSICS LAB****Credits: Practicals-02****Lab: 40 Lectures**

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
3. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
4. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
5. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer PRT.
6. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.
7. To calibrate a thermocouple to measure temperature in a specified range using  
(1) Null Method, (2) Direct measurement using Op-Amp difference amplifier and to determine Neutral Temperature.

**Reference Books**

- Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
  - A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11<sup>th</sup> Ed., 2011, Kitab Mahal
  - Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4<sup>th</sup> Edition, reprinted 1985, Heinemann Educational Publishers
  - A Laboratory Manual of Physics for undergraduate classes, D.P. Khandelwal, 1985, Vani Pub.
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## PHYSICS-C VII: DIGITAL SYSTEMS AND APPLICATIONS

Credits: Theory-04, Practicals-02

Theory: 40 Lectures

**Introduction to CRO:** Block Diagram of CRO. Electron Gun, Deflection System and Time Base. Deflection Sensitivity. Applications of CRO: 1 Study of Waveform, 2 Measurement of Voltage, Current, Frequency, and Phase Difference. **3L**

**Integrated Circuits** Qualitative treatment only: Active & Passive components. Discrete components. Wafer. Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI basic idea and definitions only. Classification of ICs. Examples of Linear and Digital ICs. **3L**

**Digital Circuits:** Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT Gates realization using Diodes and Transistor. NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity Checkers. **5L**

**Boolean algebra:** De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (I) Sum of Products Method and (II) Karnaugh Map. **3L**

**Data processing circuits:** Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders. **2L**

**Arithmetic Circuits:** Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors. **3L**

**Sequential Circuits:** SR, D, and JK Flip-Flops. Clocked Level and Edge Triggered Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S JK Flip-Flop. **6L**

**Timers:** IC 555: block diagram and applications: Astablemultivibrator and Monostable multivibrator. **2L**

**Shift registers:** Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers only up to 4 bits. **2L**

**Counters 4 bits:** Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter. **2L**

**Computer Organization:** Input/Output Devices. Data storage idea of RAM and ROM. Computer memory. Memory organization & addressing. Memory Interfacing. Memory Map. **3L**

**Intel 8085 Microprocessor Architecture:** Main features of 8085. Block diagram. Components. Pin-out diagram. Buses. Registers. ALU. Memory. Stack memory. Timing & Control circuitry. Timing states. Instruction cycle, Timing diagram of MOV and MVI. **4L**

**Introduction to Assembly Language:** 1 byte, 2 byte & 3 byte instructions. **2 L**

### Reference Books:

- Digital Principles and Applications, A.P. Malvino, D.P. Leach and Saha, 7<sup>th</sup> Ed., 2011, Tata McGraw
- Fundamentals of Digital Circuits, Anand Kumar, 2<sup>nd</sup> Edn, 2009, PHI Learning Pvt. Ltd.
- Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
- Digital Systems: Principles & Applications, R.J. Tocci, N.S. Widmer, 2001, PHI Learning
- Logic circuit design, Shimon P. Vingron, 2012, Springer.
- Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
- Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.



## PHYSICS PRACTICAL-C VII DIGITAL SYSTEMS AND APPLICATIONS

Credits: Practicals-02

LAB: 40 Lectures

1. To measure a Voltage, and b Time period of a periodic waveform using CRO.
2. To test a Diode and Transistor using a Multimeter.
3. To design a switch NOT gate using a transistor.
4. To verify and design AND, OR, NOT and XOR gates using NAND gates.
5. To design a combinational logic system for a specified Truth Table.
6. To convert a Boolean expression into logic circuit and design it using logic gate ICs.
7. To minimize a given logic circuit.
8. Half Adder, Full Adder and 4-bit binary Adder.
9. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder IC.
10. To build Flip-Flop RS, Clocked RS, D-type and JK circuits using NAND gates.
11. To build JK Master-slave flip-flop using Flip-Flop ICs
12. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram.
13. To make a 4-bit Shift Register serial and parallel using D-type/JK Flip-Flop ICs.
14. To design an astable multivibrator of given specifications using 555 Timer.
15. To design a monostable multivibrator of given specifications using 555 Timer.
16. Write the following programs using 8085 Microprocessor
  - a) Addition and subtraction of numbers using direct addressing mode
  - b) Addition and subtraction of numbers using indirect addressing mode
  - c) Multiplication by repeated addition.
  - d) Division by repeated subtraction.
  - e) Handling of 16-bit Numbers.
  - f) Use of CALL and RETURN Instruction.
  - g) Block data handling.
  - h) Other programs e.g. Parity Check, using interrupts, etc..

### Reference Books:

- Modern Digital Electronics, R.P. Jain, 4<sup>th</sup> Edition, 2010, Tata McGraw Hill.
  - Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, McGraw Hill.
  - Microprocessor Architecture Programming and applications with 8085, R.S. Goankar, 2002, Prentice Hall.
  - Microprocessor 8085: Architecture, Programming and interfacing, A. Wadhwa, 2010, PHI Learning.
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## Semester IV

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### PHYSICS-C VIII: MATHEMATICAL PHYSICS-III

**Credits: Theory-04**

**Theory: 40 Lectures**

*The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.*

**Complex Analysis:** Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles and branch points, order of singularity, branch cuts. Integration of a function of a complex variable. Cauchy's Inequality. Cauchy's Integral formula. Simply and multiply connected region. Laurent and Taylor's expansion. Residues and Residue Theorem. Application in solving Definite Integrals. **20L**

**Integrals Transforms:**

**Fourier Transforms:** Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric, Gaussian, finite wave train & other functions. Representation of Dirac delta function as a Fourier Integral. Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem. Properties of Fourier transforms translation, change of scale, complex conjugation, etc.. Three dimensional Fourier transforms with examples. Application of Fourier Transforms to differential equations: One dimensional Wave and Diffusion/Heat Flow Equations. **10L**

**Laplace Transforms:** Laplace Transform LT of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT. Application of Laplace Transforms to Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits. **10L**

**Reference Books:**

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3<sup>rd</sup> ed., 2006, Cambridge University Press
- Mathematics for Physicists, P. Dennery and A. Krzywicki, 1967, Dover Publications
- Complex Variables, A.S. Fokas & M.J. Ablowitz, 8<sup>th</sup> Ed., 2011, Cambridge Univ. Press
- Complex Variables and Applications, J.W. Brown & R.V. Churchill, 7<sup>th</sup> Ed. 2003, Tata McGraw-Hill
- First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett

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## PHYSICS PRACTICAL-C VIII MATHEMATICAL PHYSICS-III

Credits: Laboratory-02

LAB: 40 Lectures

*Scilab based simulations experiments based on Mathematical Physics problems like*

1. Solve differential equations:

$$dy/dx = e^{-x} \text{ with } y = 0 \text{ for } x = 0$$

$$dy/dx + e^{-x}y = x^2$$

$$d^2y/dt^2 + 2 dy/dt = -y$$

$$d^2y/dt^2 + e^{-t}dy/dt = -y$$

2. Dirac DeltaFunction:

Evaluate  $\frac{1}{\sqrt{2\pi\sigma^2}} \int e^{-\frac{(x\pm 2)^2}{2\sigma^2}} (x + 3)dx$ , for  $\sigma=1, .1, .01$  and show it tends to 5.

3. FourierSeries:

Program to sum  $\sum_{n=1}^{\infty} (0.2)^n$

Evaluate the Fourier coefficients of a given periodic function square wave

4. Calculation of error for each data point of observations recorded in experiments done in previous semesters choose anytwo.
5. Calculation of least square fitting manually without giving weightage to error. Confirmation of least square fitting of data through computerprogram.
6. Evaluation of trigonometric functions e.g.  $\sin \theta$ , Given Bessel's function at N points find its value at anintermediate point. Complex analysis: Integrate  $1/x^2+2$  numerically and check with computerintegration.
7. Integral transform: FFT of

### Reference Books:

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3<sup>rd</sup> ed., 2006, Cambridge UniversityPress
- Mathematics for Physicists, P. Dennery and A. Krzywicki, 1967, DoverPublications
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. VandeWouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN:978-3319067896
- Scilab by example: M. Affouf, 2012. ISBN:978-1479203444
- Scilab A free software to Matlab: H.Ramchandran, A.S.Nair. 2011 S.Chand&Company
- Scilab Image Processing: Lambert M. Surhone. 2010 BetascriptPublishing



## **PHYSICS-C IX: ELEMENTS OF MODERN PHYSICS**

**Credits: Theory-04, Practicals-02**

**Theory: 40 Lectures**

Planck's quantum, Planck's constant and light as a collection of photons; Blackbody Radiation: Quantum theory of Light; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Two-Slit experiment with electrons. Probability. Wave amplitude and wave functions. **10 L**

Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle Uncertainty relations involving Canonical pair of variables; Derivation from Wave Packets impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle- application to virtual particles and range of an interaction. **4 L**

Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of a wave function, probabilities and normalization; Probability and probability current densities in one dimension. **6 L**

One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; Quantum dot as example; Quantum mechanical scattering and tunnelling in one dimension- across a step potential & rectangular potential barrier. **6 L**

Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, Liquid Drop model: semi-empirical mass formula and binding energy, Nuclear Shell Model and magic numbers. **4 L**

Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta decay- energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus. **5 L**

Fission and fusion- mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions driving stellar energy brief qualitative discussions. **2 L**

**Lasers:** Einstein's A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Three-Level and Four-Level Lasers. Ruby Laser and He-Ne Laser. **3 L**

### **Reference Books:**

- Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
- Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill

- Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
- Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
- Quantum Mechanics: Theory & Applications, A.K. Ghatak & S. Lokanathan, 2004, Macmillan

#### **Additional Books for Reference**

- Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PHI Learning.
- Theory and Problems of Modern Physics, Schaum's outline, R. Gautreau and W. Savin, 2<sup>nd</sup> Edn, Tata McGraw-Hill Publishing Co. Ltd.
- Quantum Physics, Berkeley Physics, Vol.4. E.H. Wichman, 1971, Tata McGraw-Hill Co.
- Basic ideas and concepts in Nuclear Physics, K. Heyde, 3<sup>rd</sup> Edn., Institute of Physics Pub.
- Six Ideas that Shaped Physics: Particle Behaviour like Waves, T.A. Moore, 2003, McGraw Hill

### **PHYSICS PRACTICAL-C IX ELEMENTS OF MODERN PHYSICS**

**Credits: Practicals-02**

**LAB 40 Lectures**

1. Measurement of Planck's constant using black body radiation and photo-detector
2. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light
3. To determine work function of material of filament of directly heated vacuum diode.
4. To determine the Planck's constant using LEDs of at least 4 different colours.
5. To determine the wavelength of H-alpha emission line of Hydrogen atom.
6. To determine the ionization potential of mercury.
7. To determine the absorption lines in the rotational spectrum of Iodine vapour.
8. To determine the value of  $e/m$  by a Magnetic focusing or by a Barmagnet.
9. To setup the Millikan oil drop apparatus and determine the charge of an electron.
10. To show the tunneling effect in tunnel diode using I-V characteristics.
11. To determine the wavelength of laser source using diffraction of single slit.
12. To determine the wavelength of laser source using diffraction of double slits.
13. To determine 1 wavelength and 2 angular spread of He-Ne laser using plane diffraction grating

#### **Reference Books**

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4<sup>th</sup> Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11<sup>th</sup> Edn, 2011, Kitab Mahal





## PHYSICS-C X: ANALOG SYSTEMS AND APPLICATIONS

**Credits: Theory-04, Practicals-02**

**Theory: 40 Lectures**

**Semiconductor Diodes:** P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity. PN Junction Fabrication Simple Idea. Barrier Formation in PN Junction Diode. Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode. Drift Velocity. Derivation for Barrier Potential, Barrier Width and Current for Step Junction. **6 L**

**Two-terminal Devices and their Applications:** 1 Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, 2 Zener Diode and Voltage Regulation. Principle and structure of 1 LEDs, 2 Photodiode, 3 Solar Cell. **4 L**

**Bipolar Junction transistors:** n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains  $\alpha$  and  $\beta$  Relations between  $\alpha$  and  $\beta$ . Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff and Saturation Regions. **4 L**

**Amplifiers:** Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers. **6 L**

**Coupled Amplifier:** RC-coupled amplifier and its frequency response. **2 L**

**Feedback in Amplifiers:** Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise. **4 L**

**Sinusoidal Oscillators:** Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley & Colpitts oscillators. **3 L**

**Operational Amplifiers Black Box approach:** Characteristics of an Ideal and Practical Op-Amp. IC 741 Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground. **2 L**

**Applications of Op-Amps:** 1 Inverting and non-inverting amplifiers, 2 Adder, 3 Subtractor, 4 Differentiator, 5 Integrator, 6 Log amplifier, 7 Zero crossing detector 8 Weinbridge oscillator. **6 L**

**Conversion:** Resistive network Weighted and R-2R Ladder. Accuracy and Resolution. A/D Conversion successive approximation **3 L**

**Reference Books:**

- Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-GrawHill.
  - Electronics: Fundamentals and Applications, J.D. Ryder, 2004, PrenticeHall.
  - Solid State Electronic Devices, B.G.Streetman&S.K.Banerjee, 6<sup>th</sup> Edn.,2009, PHILearning
  - Electronic Devices & circuits, S.Salivahanan&N.S.Kumar, 3<sup>rd</sup> Ed., 2012, Tata Mc-GrawHill
  - OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4<sup>th</sup> edition, 2000, PrenticeHall
  - Electronic circuits: Handbook of design & applications, U.Tietze, C.Schenk,2008,Springer
  - Semiconductor Devices: Physics and Technology, S.M. Sze, 2<sup>nd</sup> Ed., 2002, WileyIndia
  - Electronic Devices, 7/e Thomas L. Floyd, 2008, PearsonIndia
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**PHYSICS PRACTICAL-C X ANALOG SYSTEMS AND APPLICATIONS****Credits: Practicals-02****LAB: 40 Lectures**

1. To study V-I characteristics of PN junction diode, and Light emitting diode.
2. To study the V-I characteristics of a Zener diode and its use as voltage regulator.
3. Study of V-I & power curves of solar cells, and find max. power point & efficiency.
4. To study the characteristics of a Bipolar Junction Transistor in CE configuration.
5. To study the various biasing configurations of BJT for normal class A operation.
6. To design a CE transistor amplifier of a given gain mid-gain using voltage divider bias.
7. To study the frequency response of voltage gain of a RC-coupled transistor amplifier.
8. To design a Wien bridge oscillator for given frequency using an op-amp.
9. To design a phase shift oscillator of given specifications using BJT.
10. To study the Colpitt's oscillator.
11. To design a digital to analog converter DAC of given specifications.
12. To study the analog to digital converter ADC IC.
13. To design an inverting amplifier using Op-amp 741,351 for dc voltage of given gain
14. To design inverting amplifier using Op-amp 741,351 and study its frequency response
15. To design non-inverting amplifier using Op-amp 741,351 & study its frequency response
16. To study the zero-crossing detector and comparator
17. To add two dc voltages using Op-amp in inverting and non-inverting mode
18. To design a precision Differential amplifier of given I/O specification using Op-amp.
19. To investigate the use of an op-amp as an Integrator.
20. To investigate the use of an op-amp as a Differentiator.

**Reference Books:**

- Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
  - OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4<sup>th</sup> edition, 2000, PHI.
  - Electronic Principle, Albert Malvino, 2008, Tata Mc-GrawHill.
  - Electronic Devices & circuit Theory, R.L. Boylestad & L.D. Nashelsky, 2009, Pearson
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## Semester V

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### PHYSICS-C XI: QUANTUM MECHANICS AND APPLICATIONS

Credits: Theory-04, Practicals-02

Theory: 40 Lectures

**Time dependent Schrodinger equation:** Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Eigenvalues and Eigenfunctions. Position, momentum and Energy operators; commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of a Free Particle. **5 L**

**Time independent Schrodinger equation-Hamiltonian,** stationary states and energy eigenvalues; expansion of an arbitrary wavefunction as a linear combination of energy eigenfunctions; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states; Application to spread of Gaussian wave-packet for a free particle in one dimension; wave packets, Fourier transforms and momentum space wavefunction; Position-momentum uncertainty principle. **7 L**

**General discussion of bound states in an arbitrary potential-** continuity of wave function, boundary condition and emergence of discrete energy levels; application to one-dimensional problem-square well potential; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigenfunctions using Frobenius method; Hermite polynomials; ground state, zero point energy & uncertainty principle. **8 L**

**Quantum theory of hydrogen-like atoms:** time independent Schrodinger equation in spherical polar coordinates; separation of variables for second order partial differential equation; angular momentum operator & quantum numbers; Radial wavefunctions from Frobenius method; shapes of the probability densities for ground & first excited states; Orbital angular momentum quantum numbers  $l$  and  $m$ ; s, p, d, ... shells. **6 L**

**Atoms in Electric & Magnetic Fields:** Electron angular momentum. Space quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton. **5 L**

**Atoms in External Magnetic Fields:-** Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect Qualitative Discussion only. **3 L**

**Many electron atoms:** Pauli's Exclusion Principle. Symmetric & Antisymmetric Wave Functions. Periodic table. Fine structure. Spin orbit coupling. Spectral Notations for Atomic States. Total angular momentum. Vector Model. Spin-orbit coupling in atoms- L-S and J-J couplings. Hund's Rule. Term symbols. Spectra of Hydrogen and Alkali Atoms Na etc.. **6 L**

**Reference Books:**

- A Text book of Quantum Mechanics, P.M.Mathews and K.Venkatesan, 2<sup>nd</sup> Ed., 2010, McGrawHill
- Quantum Mechanics, Robert Eisberg and Robert Resnick, 2<sup>nd</sup>Edn., 2002,Wiley.
- Quantum Mechanics, Leonard I. Schiff, 3<sup>rd</sup>Edn. 2010, Tata McGrawHill.
- Quantum Mechanics, G. Aruldas, 2<sup>nd</sup>Edn. 2002, PHI Learning ofIndia.
- Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and BartlettLearning.
- Quantum Mechanics: Foundations & Applications, Arno Bohm, 3<sup>rd</sup>Edn., 1993, Springer
- Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge UniversityPress

#### **Additional Books for Reference**

- Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons,Inc.
- Introduction to Quantum Mechanics, D.J. Griffith, 2<sup>nd</sup> Ed. 2005, PearsonEducation
- Quantum Mechanics, Walter Greiner, 4<sup>th</sup>Edn., 2001, Springer

## **PHYSICS PRACTICAL-C XI Q. MECH. AND APPLICATIONS**

**Credits: Practicals-02**

**LAB: 40 Lectures**

*Use C/C++/Scilab for solving the following problems based on Quantum Mechanics like*

1. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom:  
Remember that the ground state energy of the hydrogen atom is  $\approx -13.6$  eV. Take  $e = 3.795 \text{ eV}\text{\AA}^{1/2}$ ,  $hc = 1973 \text{ eV}\text{\AA}$  and  $m = 0.511 \times 10^6 \text{ eV}/c^2$ .
2. Solve the s-wave radial Schrodinger equation for another atom:
3. Solve the Schrodinger equation for harmonic oscillation.
4. Solve the Schrodinger equation for the vibrations of hydrogen molecule as an anharmonic oscillator.

#### **Laboratory based experiments:**

5. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency
6. Study of Zeeman effect: with external magnetic field; Hyperfine splitting
7. To show the tunneling effect in tunnel diode using I-V characteristics.
8. Quantum efficiency of CCDs

#### **Reference Books:**

- Schaum's outline of Prog. with C++. J.Hubbard, 2000, McGraw-Hill Publication
- Numerical Recipes in C: The Art of Scientific Computing, W.H. Press et al., 3<sup>rd</sup> Edn., 2007, Cambridge University Press.
- An introduction to comp.I Physics, T.Pang, 2<sup>nd</sup> Edn., 2006, Cambridge Univ. Press
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific & Engineering Applications: A. VandeWouwer, P. Saucez, C. V. Fernández. 2014 Springer.
- Scilab A Free Software to Matlab: H. Ramchandran, A.S. Nair. 2011 S. Chand & Co.
- Scilab Image Processing: L.M. Surhone. 2010 Betascript Publishing ISBN: 978-6133459274



## PHYSICS-C XII: SOLID STATE PHYSICS

Credits: Theory-04, Practicals-02

Theory: 40 Lectures

**Crystal Structure:** Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor. **8 L**

**Elementary Lattice Dynamics:** Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids.  $T^3$  law **6 L**

**Magnetic Properties of Matter:** Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia- and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss. **6 L**

**Dielectric Properties of Materials:** Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeier relations. Langevin-Debye equation. Complex Dielectric Constant. Optical Phenomena. Application: Plasma Oscillations, Plasma Frequency, Plasmons, TO modes. **5 L**

**Ferroelectric Properties of Materials:** Structural phase transition, Classification of crystals, Piezoelectric effect, Pyroelectric effect, Ferroelectric effect, Electrostrictive effect, Curie-Weiss Law, Ferroelectric domains, P-E hysteresis loop. **5 L**

**Elementary band theory:** Kronig Penny model. Band Gap. Conductor, Semiconductor P and N type and insulator. Conductivity of Semiconductor, mobility, Hall Effect. Measurement of conductivity 04 probe method & Hall coefficient. **6 L**

**Superconductivity:** Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect. Idea of BCS theory. Derivation **4 L**

### Reference Books:

- Introduction to Solid State Physics, Charles Kittel, 8<sup>th</sup> Edition, 2004, Wiley India Pvt. Ltd.
- Elements of Solid State Physics, J.P. Srivastava, 2<sup>nd</sup> Edition, 2006, Prentice-Hall of India
- Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill
- Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning
- Solid-state Physics, H. Ibach and H. Luth, 2009, Springer
- Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India
- Solid State Physics, M.A. Wahab, 2011, Narosa Publications

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## PHYSICS PRACTICAL-C XII SOLID STATE PHYSICS

**Credits: Practicals-02**

**LAB: 40 Lectures**

1. Measurement of susceptibility of paramagnetic solution Quinck's Tube Method
2. To measure the Magnetic susceptibility of Solids.
3. To determine the Coupling Coefficient of a Piezoelectric crystal.
4. To measure the Dielectric Constant of a dielectric Materials with frequency
5. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance SPR
6. To determine the refractive index of a dielectric layer using SPR
7. To study the PE Hysteresis loop of a Ferroelectric Crystal.
8. To draw the BH curve of Fe using Solenoid & determine energy loss from Hysteresis.
9. To measure the resistivity of a semiconductor Ge with temperature by four-probe method room temperature to 150 °C and to determine its bandgap.
10. To determine the Hall coefficient of a semiconductor sample.

### Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
  - Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4<sup>th</sup> Edition, reprinted 1985, Heinemann Educational Publishers.
  - A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11<sup>th</sup> Ed., 2011, Kitab Mahal
  - Elements of Solid State Physics, J.P. Srivastava, 2<sup>nd</sup> Ed., 2006, Prentice-Hall of India.
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## Semester VI

### PHYSICS-C XIII: ELECTROMAGNETIC THEORY

**Credits: Theory-04, Practicals-02**

**Theory: 40 Lectures**

**Maxwell Equations:** Review of Maxwell's equations. Displacement Current. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Boundary Conditions at Interface between Different Media. Wave Equations. Plane Waves in Dielectric Media. Poynting Theorem and Poynting Vector. Electromagnetic EM Energy Density. Physical Concept of Electromagnetic Field Energy Density, Momentum Density and AngularMomentumDensity. **8 L**

**EM Wave Propagation in Unbounded Media:** Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Propagation through conducting media, relaxation time, skin depth. Wave propagation through dilute plasma, electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth, application to propagation throughionosphere. **6 L**

**EM Wave in Bounded Media:** Boundary conditions at a plane interface between two media. Reflection & Refraction of plane waves at plane interface between two dielectric media-Laws of Reflection & Refraction. Fresnel's Formulae for perpendicular & parallel polarization cases, Brewster's law. Reflection & Transmission coefficients. Total internal reflection, evanescent waves. Metallic reflection normalIncidence **6 L**

**Polarization of Electromagnetic Waves:** Description of Linear, Circular and Elliptical Polarization. Propagation of E.M. Waves in Anisotropic Media. Symmetric Nature of Dielectric Tensor. Fresnel's Formula. Uniaxial and Biaxial Crystals. Light Propagation in Uniaxial Crystal. Double Refraction. Polarization by Double Refraction. Nicol Prism. Ordinary & extraordinary refractive indices. Production & detection of Plane, Circularly and Elliptically Polarized Light. Phase Retardation Plates: Quarter-Wave and Half-Wave Plates. Babinet Compensator and its Uses. Analysis of Polarized Light **8 L**

Rotatory Polarization: Optical Rotation. Biot's Laws for Rotatory Polarization. Fresnel's Theory of optical rotation. Calculation of angle of rotation. Experimental verification of Fresnel's theory. Specific rotation. Laurent's half-shadepolarimeter. **4 L**

**Wave Guides:** Planar optical wave guides. Planar dielectric wave guide. Condition of continuity at interface. Phase shift on total reflection. Eigenvalue equations. Phase and group velocity of guided waves. Field energy and Power transmission. **6 L**

**Optical Fibres:-** Numerical Aperture. Step and Graded Indices Definitions Only. Single and Multiple Mode Fibres Concept andDefinitionOnly. **2 L**

#### Reference Books:

- Introduction to Electrodynamics, D.J. Griffiths, 3<sup>rd</sup> Ed., 1998, BenjaminCummings.
- Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford UniversityPress.
- Introduction to Electromagnetic Theory, T.L. Chow, 2006, Jones & BartlettLearning
- Fundamentals of Electromagnetics, M.A.W. Miah, 1982, Tata McGrawHill

- Electromagnetic field Theory, R.S. Kshetrimayun, 2012, Cengage Learning
- Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

#### **Additional Books for Reference**

- Electromagnetic Fields & Waves, P. Lorrain & D. Corson, 1970, W.H. Freeman & Co.
  - Electromagnetics, J.A. Edminster, Schaum Series, 2006, Tata McGraw Hill.
  - Electromagnetic field theory fundamentals, B. Guru and H. Hiziroglu, 2004, Cambridge University Press
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## **PHYSICS PRACTICAL-C XIII ELECTROMAGNETIC THEORY**

**Credits: Practicals-02**

**LAB: 40 Lectures**

1. To verify the law of Malus for plane polarized light.
2. To determine the specific rotation of sugar solution using Polarimeter.
3. To analyze elliptically polarized Light by using a Babinet's compensator.
4. To study dependence of radiation on angle for a simple Dipole antenna.
5. To determine the wavelength and velocity of ultrasonic waves in a liquid Kerosene Oil, Xylene, etc. by studying the diffraction through ultrasonic grating.
6. To study the reflection, refraction of microwaves
7. To study Polarization and double slit interference in microwaves.
8. To determine the refractive index of liquid by total internal reflection using Wollaston's air-film.
9. To determine the refractive Index of 1 glass and 2 a liquid by total internal reflection using a Gaussian eyepiece.
10. To study the polarization of light by reflection and determine the polarizing angle for air-glass interface.
11. To verify the Stefan's law of radiation and to determine Stefan's constant.
12. To determine the Boltzmann constant using V-I characteristics of PN junction diode.

#### **Reference Books**

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
  - Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4<sup>th</sup> Edition, reprinted 1985, Heinemann Educational Publishers
  - A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11<sup>th</sup> Ed., 2011, Kitab Mahal
  - Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer
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## PHYSICS-C XIV: STATISTICAL MECHANICS

**Credits: Theory-04, Practicals-02**

**Theory: 60 Lectures**

**Classical Statistics:** Macrostate & Microstate, Elementary Concept of Ensemble, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Sackur Tetrode equation, Law of Equipartition of Energy with proof – Applications to Specific Heat and its Limitations, Thermodynamic Functions of a Two-Energy Levels System, Negative Temperature.

**12 L**

**Classical Theory of Radiation:** Properties of Thermal Radiation. Blackbody Radiation. Pure temperature dependence. Kirchhoff's law. Stefan-Boltzmann law: Thermodynamic proof. Radiation Pressure. Wien's Displacement law. Wien's Distribution Law. Saha's Ionization Formula. Rayleigh-Jean's Law. Ultraviolet Catastrophe.

**6 L**

**Quantum Theory of Radiation:** Spectral Distribution of Black Body Radiation. Planck's Quantum Postulates. Planck's Law of Blackbody Radiation: Experimental Verification. Deduction of 1 Wien's Distribution Law, 2 Rayleigh-Jeans Law, 3 Stefan-Boltzmann Law, 4 Wien's Displacement law from Planck's law.

**4 L**

**Bose-Einstein Statistics:** B-E distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation, properties of liquid He qualitative description, Radiation as a photon gas and Thermodynamic functions of photon gas. Bose derivation of Planck's law.

**8 L**

**Fermi-Dirac Statistics:** Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals, Relativistic Fermi gas, White Dwarf Stars, Chandrasekhar Mass Limit.

**10 L**

### Reference Books:

- Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2<sup>nd</sup> Ed., 1996, Oxford University Press.
- Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill
- Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall
- Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
- An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ. Press



## PHYSICS PRACTICAL-C XIV STATISTICAL MECHANICS

Credits: Theory-04, Practicals-02

LAB:40 Lectures

*Use C/C++/Scilab for solving the problems based on Statistical Mechanics like*

1. Plot Planck's law for Black Body radiation and compare it with Wein's Law and Raleigh-Jeans Law at high temperature room temperature and lowtemperature.
2. Plot Specific Heat of Solids by comparing a Dulong-Petit law, b Einstein distribution function, c Debye distribution function for high temperature room temperature and low temperature and compare them for these twocases
3. Plot Maxwell-Boltzmann distribution function versustemperature.
4. Plot Fermi-Dirac distribution function versustemperature.
5. Plot Bose-Einstein distribution function versustemperature.

### Reference Books:

- Elementary Numerical Analysis, K.E. Atkinson, 3<sup>rd</sup> Edn. 2007, Wiley India Edition
  - Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2<sup>nd</sup> Ed., 1996, Oxford University Press.
  - Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
  - Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
  - Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. VandeWouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN:978-3319067896
  - Scilab by example: M. Affouf, 2012. ISBN:978-1479203444
  - Scilab Image Processing: L.M. Surhone. 2010, Betascript Pub., ISBN: 978- 6133459274
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